

THREE NEW SPECIES OF TUBIFICIDAE
(OLIGOCHAETA) FROM AN OIL SEEPAGE AREA
ON THE CONTINENTAL SLOPE OF THE
NORTHERN GULF OF MEXICO

Christer Erséus and Michael R. Milligan

Abstract.—*Limnodriloides olearius* (subfamily Limnodriloidinae), *Tubificoides paracrinitus*, and *T. pequegnatae* (Tubificinae) are described from a hydrocarbon seep area of vestimentiferan growth at 540 m depth south of Louisiana. The tubificids are associated with vestimentiferans, mussels and bacterial mats. *Limnodriloides olearius* belongs to the *winckelmanni*-group within the genus, but is unique by its possession of transverse patches of epidermal glands ventrally in segments III–X. *Tubificoides paracrinitus* is closely related to *T. crinitus* Erséus, 1989, but is larger and possesses postclitellar body wall papillae, a greater number of setae, and different penes and spermathecae; *T. pequegnatae* resembles *T. bakeri* Brinkhurst, 1985 in its setal distribution, but differs in the morphology of its penis sheaths.

Five samples of oligochaetes, from an area of natural hydrocarbon seepage on the Gulf of Mexico continental slope about 128 km south of Louisiana, were sent to the senior author for identification. They represented three new species of Tubificidae (one species of *Limnodriloides* Pierantoni, two of *Tubificoides* Lastockin) described in the present paper.

The samples were collected from the submersible *Johnson Sea Link I*, Dive No. 1878 (28 Sep 1986), at "Bush Hill," an area of thick growths of tube worms, mussel beds and bacterial mats in Blocks 184 and 185 of the Green Canyon offshore oil leasing area (cf. Brooks et al. 1987); oil leasing blocks being set by the U.S. Department of Interior, Minerals Management Service. The worms were provided by LGL Ecological Research Associates, Inc. (Bryan, Texas). Only two or three sexually mature individuals of each species were found. The specimens were stained in paracarmine and mounted whole in Canada balsam, and have been deposited as type specimens in the U.S. National Museum of Natural History

(USNM), Smithsonian Institution, Washington, D.C.

Subfamily Limnodriloidinae

Limnodriloides olearius, new species
Fig. 1.

Holotype.—USNM 119904, 2.4 mm long, consisting of first 15 segments only, from S of Louisiana, 27°46'56"N, 91°30'20"W, 540 m (28 Sep 1986), in area of vestimentiferan growth.

Paratype.—USNM 119905, from type locality.

Etymology.—The epithet *olearius* is Latin for "of oil," here alluding to the species' occurrence in an area of oil seepage.

Description.—Length more than 4.2 mm, more than about 35 segments (no specimen complete); width at XI in whole-mounted, compressed specimens about 0.25 mm. Prostomium rounded triangular. Clitellum not distinct in available specimens. Very distinct, transverse, elongated patches of epidermal glands present ventrally in most of preclitellar segments, at least in III–X

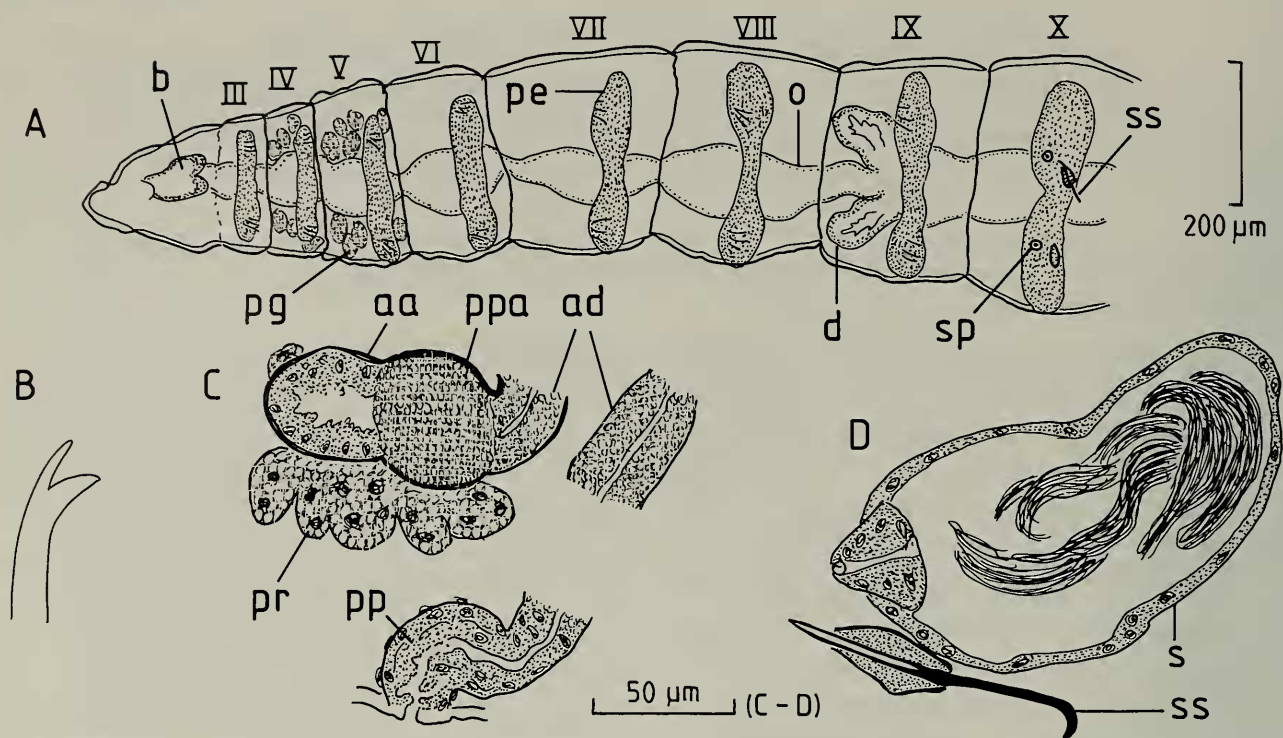


Fig. 1. *Limnodriloides olearius*, n. sp.: A, Ventral view of anterior end of worm (semi-schematic); B, Free-hand drawing of somatic seta; C, Three (probably all) parts of one atrium, holotype; D, Spermatheca and spermathecal seta. Abbreviations: *aa* atrial ampulla; *ad* atrial duct; *b* brain; *d* oesophageal diverticula; *o* oesophagus; *pe* patch of epidermal glands; *pg* pharyngeal glands; *pp* pseudopenis; *ppa* prostatic pad; *pr* prostate gland; *s* spermatheca; *sp* spermathecal pore; *ss* spermathecal seta; Roman numerals denoting segment numbers.

(Fig. 1A, *pe*); bundles of ventral setae and (in X) spermathecal pores located within these glandular patches. Somatic setae (Fig. 1B) bifid, with upper tooth as long as but thinner than lower; bifids 40–70 μm long, about 2.5 μm thick, (two) three (four) per bundle anteriorly, two per bundle in postclitellar segments. In holotype and paratype, one spermathecal seta (Fig. 1D, *ss*), partly enclosed in narrow (glandular?) sac, present immediately posterior to one of the two spermathecal pores in X; at other side of X setal sac empty (spermathecal seta lacking; see Fig. 1A). Spermathecal seta, single-pointed, shaped like a walking-stick, about 100–110 μm long, about 3.5 μm at node, with node at about middle, and with part ectal to node grooved; large gland associated with sac of spermathecal seta not observed, but may be present (as in some congeners; see, e.g., Erséus 1982:figs. 15, 20–21). Penial setae absent; male pores paired, somewhat ventral to lines of ventral setae, in middle-to-posterior part of XI; sper-

mathecal pores paired, in line with ventral setae, in middle of X.

Pharyngeal glands (Fig. 1A, *pg*) present in IV–V. Large, somewhat conical oesophageal diverticula (Fig. 1A, *d*) present in IX. Male genitalia (Fig. 1C) paired, not well preserved in available material; vas deferens 9–14 μm wide, but length and junction with atrium not established. Atrial ampulla 75–80 μm long, about 45 μm wide, with ectal half filled with large, conspicuous prostatic pad; muscular lining of ampulla 2–3 μm thick in paratype, thinner in holotype (Fig. 1C); prostate gland lobed. Atrial duct (broken into pieces in holotype; not visible in paratype) slender, about 135 μm long, 21–28 μm wide, granulated for most parts, terminating in simple pseudopenis with somewhat folded inner wall; inner structure of pseudopenis not clear, but no distinct pseudopenial papilla appears to be present. Spermathecae (Fig. 1D, *s*) large, consisting of very short, triangular ducts, and oval, up to about 170 μm long, 75 μm wide, ampullae;

sperm arranged as distinct, curved bundles in spermathecae; possibly they are (poorly preserved) spermatozeugmata.

Remarks.—The function of the conspicuous patches of epidermal glands in the anterior segments is unknown. It appears likely, however, that they are in some ways related to reproduction as such patches are not developed in four juvenile specimens of *Limnodriloides* found at the type locality, and presumably belonging to the same species. Patches of epidermal glands have not been reported for *Limnodriloides* before, and they are in fact distinguishing *L. olearius* from all other members of the subfamily Limnodriloidinae, but similar glands are present dorsally (largely in post-clitellar segments) in some species of *Bathydrilus* Cook, in the subfamily Phallo-drilinae (Erséus 1986:figs. 9A–B).

The new species is a member of the *winckelmanni*-group within *Limnodriloides*, i.e., the species with spermathecal setae (Erséus 1982). Both type specimens lack the spermathecal seta at one side of segment X, but this asymmetric arrangement is not necessarily a specific character; other species within the group occasionally lack one or both spermathecal setae (e.g., *L. victoriensis* Brinkhurst & Baker, 1979; see Brinkhurst & Baker 1979; Erséus 1982).

Among those species in the *winckelmanni*-group that have: (1) a pair of esophageal diverticula in segment IX, and (2) well separated male pores, *L. olearius* appears most closely related to *L. barnardi* Cook, 1974, a common species in the Northwest Atlantic and the Caribbean, and also known from the Pacific coast of Mexico; both species have elongate atrial ampullae with the prostatic pads located in the ectal half of these ampullae (Fig. 1C; Erséus 1982:fig. 13A). *Limnodriloides olearius* is distinguished from the latter by its shorter spermathecal ducts, and its very simple pseudopenes. In *L. barnardi*, the atrial ducts terminate in distinct pseudopenial papillae (Erséus 1982:fig. 13A–B), which in fact were erroneously interpreted as proper penes by the original

author (Cook 1974). The male genitalia are not very well preserved in the material of *L. olearius*, but there is no indication of such discrete papillae in the copulatory organs (Fig. 1C, pp).

Distribution and habitat.—Only known from the type locality, N Gulf of Mexico. Upper continental slope, 540 m depth.

Subfamily Tubificinae

Tubificoides paracrinatus, new species

Fig. 2

Holotype.—USNM 119901, whole-mounted specimen from south of Louisiana, 27°47'01"N, 91°30'03"W, 582.5 m (28 Sep 1986), in area free of vestimentiferan growth, but not very far from the hydrocarbon seep.

Paratypes.—USNM 119902, 119903, two whole-mounted specimens from 27°46'56"N, 91°30'20"W, 540.1 m (28 Sep 1986), in area of vestimentiferan growth.

Etymology.—Named *paracrinatus* for its resemblance to *T. crinitus* Erséus, 1989.

Description.—Length of holotype 27.1 mm, 53 segments; paratypes not complete; width at XI in whole-mounted, compressed specimens 0.25–0.27 mm. Prostomium pointed triangular. Body wall naked anteriorly, but covered with very small papillae in most of postclitellar segments (papillation not beginning immediately behind clitellar region). Clitellum poorly developed. Anterior dorsal bundles with up to six hair-like, generally single-pointed, crotchets, 55–95 μm long (occasionally such a seta bifid with minute teeth), alternating with about the same number of long hair setae, 200–250 μm long; postclitellar dorsal bundles similar to anterior ones, but setal number and length generally not as great; anterior ventral bundles with two to four bifid setae (Fig. 2A), 65–80 μm long, with very slender, thin and almost parallel teeth, upper tooth tending to be longer than lower; postclitellar ventral bundles with two to three setae, similar to anterior ventrals or sharply single-pointed. Ventral setae of XI, and sometimes

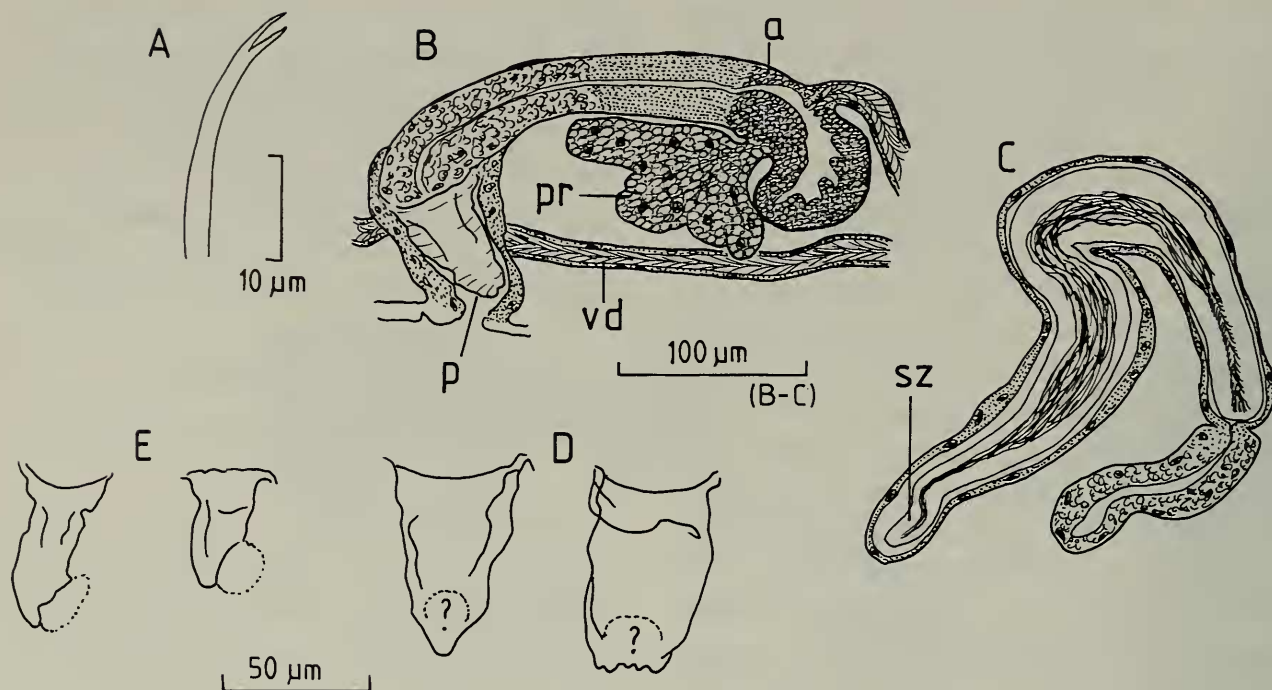


Fig. 2. A–D, *Tubificoides paracrinitus*, n. sp.: A, Ventral anterior seta; B, Male genitalia; C, Spermatheca; D, Penis sheaths; E, *Tubificoides crinitus* Erséus, penis sheaths. Abbreviations: a atrium; p penis; pr prostate gland; sz spermatheca; vd vas deferens.

of X, absent. Spermathecal pores in line with (and near) ventral setae (if present) in middle of X; male pores in line with ventral setae slightly posterior to middle of XI.

Pharyngeal glands in IV–V. Esophagus somewhat enlarged in IX. Male genitalia (Fig. 2B) paired; vas deferens 14–18 μm wide, thin-walled and ciliated, at least about three times longer than atrium, entering latter subapically. Atrium cylindrical, up to about 290 μm long, 33–52 μm wide, histologically tripartite, with up to about 2 μm thick lining of muscles; ental part of atrium more heavily granulated than remaining part; prostate gland lobed, attached to atrium opposite to entrance of vas deferens. Penis (Fig. 2D) with conical, thimble-shaped penis sheath, 70–90 μm long, basally 40–47 μm wide, ectally 27–35 μm wide, with indistinct, terminal or somewhat subterminal(?) opening. Spermathecae (Fig. 2C) with ducts 130–210 μm long, 35–50 μm wide, somewhat glandular and with a hollow ectal swelling; ampullae and spermathegmata slender in postcopulatory specimens; sperm trap present(?).

Remarks. — *Tubificoides paracrinitus* is

closely related to *T. crinitus* Erséus, 1989, which is simultaneously described from non-seep areas in the same part of the Gulf of Mexico (Erséus 1989b), but it differs from the latter in several respects: (1) it is distinctly larger (0.25–0.27 mm wide at segment XI, as opposed to 0.13–0.22 mm for *crinitus*; length of latter unknown); (2) it has discrete body wall papillae in postclitellar segments (*crinitus* has fine particles scattered over postclitellar segments, but no papillae are formed); (3) it has up to six crotchets and about the same number of hairs in the dorsal bundles (setae only half as many in *crinitus*); (4) occasionally its dorsal crotchets are bifid (well visible in segment V of holotype)(all dorsal crotchets of *crinitus* hair-like and single-pointed); (5) its penis sheaths (Fig. 2D) appear to have smaller and not as lateral openings, as those of the sheaths of *crinitus* (Fig. 2E, shown here for comparison); and (6) its much more slender spermathecae (Fig. 2C) (the spermathecal ampullae of *crinitus* are small and oval). Some of these differences could perhaps, per se, be regarded as intraspecific rather than interspecific, but taken together

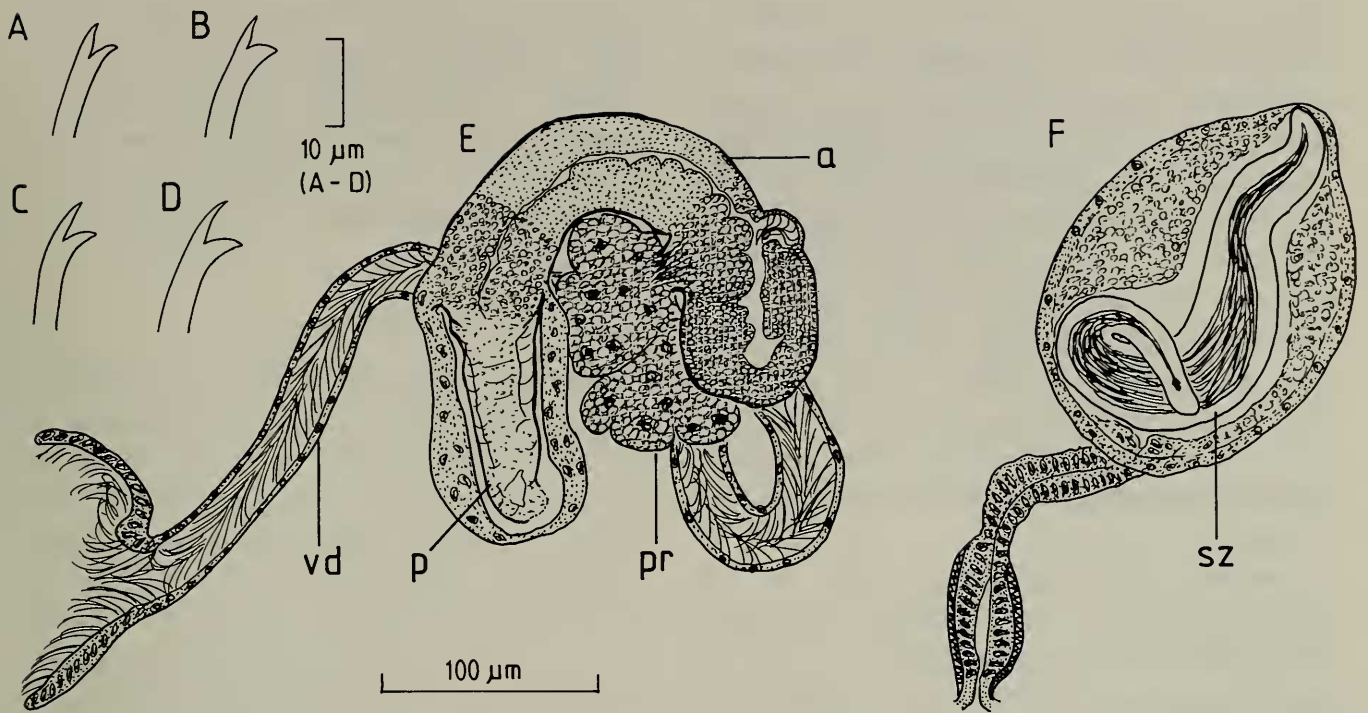


Fig. 3. *Tubificoides pequegnatae*, n. sp.: A, Anterior dorsal bifid seta; B, Posterior dorsal bifid seta; C, Anterior ventral seta; D, Posterior ventral seta; E, Male genitalia; F, Spermatheca. Abbreviations as for Fig. 2.

they certainly indicate that the two forms are separate species.

Distribution and habitat.—Known only from the Gulf of Mexico. Upper continental slope, 540–582 m depth.

Tubificoides pequegnatae, new species

Fig. 3

Holotype.—USNM 119896, whole-mounted specimen from 27°46'56"N, 91°30'20"W, 540.1 m (28 Sep 1986), in area of vestimentiferan growth.

Paratypes.—USNM 119897–119900, four whole-mounted specimens (three of which sexually immature) from type locality.

Etymology.—Named for Dr. Linda H. Pequegnat, who very kindly provided the present material.

Description.—Length of holotype 3.5 mm, 13+ segments (posterior end partially regenerating); sexually mature paratype 2.6 mm, 17 segments, but incomplete. Width at XI in whole-mounted, compressed specimens, 0.32–0.46 mm. Prostomium rounded, somewhat broadly triangular. Body wall naked anteriorly, but coated with fine par-

ticles with a tendency to form papillae in postclitellar segments. Clitellum poorly developed. Anterior dorsal bundles with (one) two to three bifid setae, 45–75 μm long, upper slightly longer than lower (Fig. 3A), and (one) two to three hair setae, 115–140 μm long; postclitellar dorsal bundles generally with two bifid setae, upper tooth longer and thinner than lower (Fig. 3B), and occasionally in a few segments immediately posterior to clitellum one hair seta may be present; anterior ventral bundles with three to four bifid setae, 60–75 μm long, upper tooth tending to be longer and thinner than lower (Fig. 3C); postclitellar ventral bundles with two setae (Fig. 3D), similar to anterior ventrals. Ventral setae of X and XI absent. Spermathecal and male pores in line with ventral setae in middle of X and XI, respectively.

Pharyngeal glands in IV–VI. Male genitalia (Fig. 3E) paired; vas deferens about 20 μm wide, thin-walled and ciliated, at least three times longer than atrium, entering latter subapically. Atrium cylindrical, up to about 235 μm long, histologically tripartite, with up to 2 μm thick lining of muscles,

ental part of atrium more heavily granulated than remaining part, about 70 μm wide, middle part about 40 μm wide. Prostate gland lobed, attached to atrium opposite to entrance of vas deferens; penis with elongate, funnel-shaped sheath, 75–105 μm long, basally 37 μm wide, with somewhat subterminal opening. Spermathecae (Fig. 3F) with ducts 130 μm long, 20–25 μm wide, ectal region slightly bulbous with a thickened muscular covering; ampullae ovoid, 180–190 μm long, 135–150 μm wide; spermatozogmata long and slender; sperm trap not seen.

Remarks.—This species is similar to the Northeast Pacific *T. bakeri* Brinkhurst, 1985 with regard to its setal distribution; no other described species in the genus with hairs and bifid setae anteriorly lacks the hair setae in the posterior segments. *Tubificoides bakeri* has a slightly greater number of anterior dorsal setae (up to four bifids, plus as many hairs) than *T. pequegnatae*, and its atria are distinctly smaller than those of the new species, but the most important difference between the two species is the shape of the penis sheaths: the penis of *T. bakeri* has a bulbous tip (Brinkhurst 1985:fig. 7B), whereas the penis of the new species continuously tapers ectally (see Fig. 3E).

Discussion

Seven species of Tubificidae were previously recorded from continental slope depths (about 300 m and deeper) in the northern Gulf of Mexico (Erséus 1988, 1989a, b): *Phallogrilus constrictus* Erséus, *P. grasslei* Erséus, *P. vescus* Erséus, *Bathydrius connexus* Erséus, *B. longiatriatus* Erséus, *Limnodriloides monotheucus* Cook and *Tubificoides crinitus* Erséus. The samples from the “Bush Hill” hydrocarbon seeps yielded three separate species, which is noteworthy considering that the area is located in the same part of the Gulf. It thus seems possible that the three new species, or at least some of them, are endemic to these hydrocarbon seep

situations. The extensive bacterial mats (often containing separate phase oil lying between them) probably provides a rich food supply to the associated macrofauna (see Brooks et al. 1987), including these (possibly specialized) tubificids.

Acknowledgments

The LGL specimens reported in this publication were collected through funding by the U.S. Department of Interior, Minerals Management Service, Gulf of Mexico Regional OCS Office under Contract Number 14-12-0001-30046 and 14-12-0001-30212. We are indebted to Dr. Linda H. Pequegnat (LGL) for providing this interesting material, and for valuable information about the collecting site, and to Ms. Barbro Löfnertz and Mrs. Aino Falck-Wahlström for technical assistance.

Literature Cited

- Brinkhurst, R. O. 1985. A further contribution to the taxonomy of the genus *Tubificoides* Lastockin (Oligochaeta, Tubificidae).—*Canadian Journal of Zoology* 63:400–410.
- , & H. R. Baker. 1979. A review of the marine Tubificidae (Oligochaeta) of North America.—*Canadian Journal of Zoology* 57:1553–1569.
- Brooks, J. M., et al. 1987. Hydrates, oil seepage, and chemosynthetic ecosystems on the Gulf of Mexico slope: an update.—*Eos, Transactions, American Geophysical Union* 68(18):498–499.
- Cook, D. G. 1974. The systematics and distribution of marine Tubificidae (Annelida: Oligochaeta) in the Bahia de San Quintin, Baja California, with descriptions of five new species.—*Bulletin of the Southern California Academy of Sciences* 73:126–140.
- Erséus, C. 1982. Taxonomic revision of the marine genus *Limnodriloides* (Oligochaeta: Tubificidae).—*Verhandlungen des naturwissenschaftlichen Vereins in Hamburg (Neue Folge)* 25:207–277.
- . 1986. Marine Tubificidae (Oligochaeta) at Hutchinson Island, Florida.—*Proceedings of the Biological Society of Washington* 99:286–315.
- . 1988. Deep-sea Tubificidae (Oligochaeta) from the Gulf of Mexico.—*Proceedings of the Biological Society of Washington* 101:67–71.

- . 1989a. *Phalodrilus vescus*, new species (Oligochaeta, Tubificidae) from the Gulf of Mexico.—Proceedings of the Biological Society of Washington 102:134–136.
- . 1989b. Four new West Atlantic species of *Tubificoides* (Oligochaeta, Tubificidae).—Proceedings of the Biological Society of Washington 102:877–886.

(CE) Zoo-tax, Swedish Museum of Natural History, Stockholm, and (postal address): Department of Zoology, University of Göteborg, Box 25059, S-400 31 Göteborg, Sweden; (MRM) Mote Marine Laboratory, 1600 City Island Park, Sarasota, Florida 33577, USA.